Early Student Support for a Statistical Investigation of Internal Wave Propagation in the Northern South China Sea

Ping-Tung Shaw
Dept of MEAS, North Carolina State University
Box 8208
Raleigh, NC 27695-8208
Phone: (919)515-7276 fax: (919)515-7802 e-mail: pt_shaw@ncsu.edu

Award Number: N00014-10-1-0470

LONG-TERM GOALS

The long-term goal of this project is to predict the generation of internal waves over the ridges in the Luzon Strait and wave propagation across the northern South China Sea.

OBJECTIVES

The objective of this study is to provide support for a student to participate in the study of the internal wave/tide propagation from the Luzon Strait to the edge of the continental shelf off China. Three issues are to be studied: 1) the relationship between the internal waves and the barotropic tides in the Luzon Strait, 2) temporal and spatial variations of internal wave properties during propagation across the deep basin of the northern South China Sea, and 3) wave transmission across the continental margin.

APPROACH

Guided by the description of the internal wave field from nonhydrostatic numerical simulation, time series analysis will be performed on simulated real-time data obtained from the Ocean Nowcast/Forecast System of Naval Research Laboratory during NLIWI. In the generation region, the study will estimate the energy conversion from the barotropic tides to baroclinic waves. Sources of the internal waves are to be identified. In the propagation region, waves will be traced back to the generation region to find the dependence of the amplitude of internal solitary wave on the conditions in the Luzon Strait.

WORK COMPLETED

In the past year, process studies on the internal wave energy flux emitting from an asymmetrical ridge with and without mean flow has been carried out. In the data analysis work, programs for studying internal wave propagation in the NRL data have been prepared and used for time series analysis on two zonal sections in the NRL data. Ms. Ying-Jung Chen, the student supported by this project, is using the tool to carry out the study.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 SEP 2011		**00-00-2011 to 00-00-2011**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Early Student Support for a Statistical Investigation of Internal Wave Propagation in the Northern South China Sea	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **North Carolina State University,Dept of MEAS,Box 8208,Raleigh,NC,27695-8208**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**3**	

RESULTS

The phase and amplitude of internal waves over a steep, tall ridge has been investigated by the PI using a nonhydrostatic model in the related project (Shaw et al., 2009). The results show that internal waves generated by the barotropic tidal currents are characterized by wave beams along slanting paths from the ridge crest. The origin of the wave can thus be traced to the reversal of the tidal current over the ridge. The study of Qian et al. (2010) further shows that the energy flux increases during the vertically propagation phase of wave beams and reaches a steady value after waves evolve into a mode-one structure.

Anticipating studying the effects of the Kuroshio, we have carried out a process study on wave generation from an asymmetrical ridge with and without a mean current. Figure 1 shows energy of internal waves generated by the semidiurnal tides from an asymmetrical ridge. The topographic slope of the ridge on the left side is critical while the right side varies from critical to subcritical. When the topographic slope on one side of the ridge becomes subcritical, energy flux is reduced on both sides, while wave energy on the steeper side is higher. A mean current generally increases the energy flux in the direction of the current, i.e., a westward mean current enhances waves propagating westward. Results from this and earlier process studies guide the study of wave generation and propagation in zonal vertical sections in the NRL data.

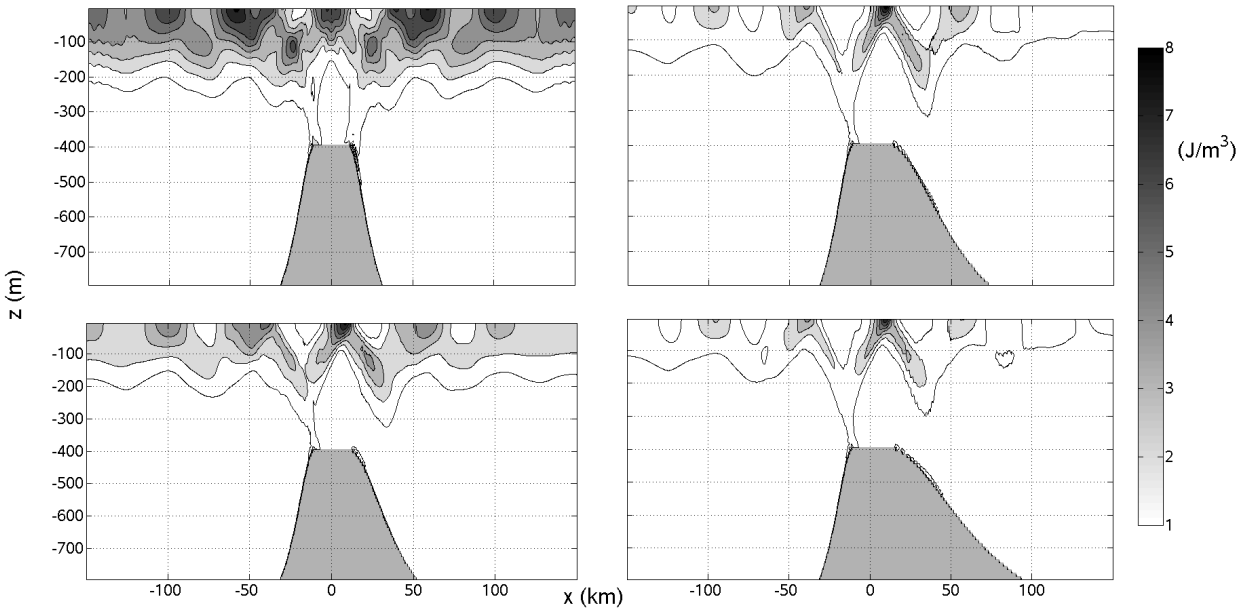

Figure 1. Contour plot of internal wave energy generated from asymmetrical ridges at the semidiurnal period. The topographic slope on the left (west) side is critical while that on the right (east) side varies from critical to subcritical. Total energy flux is reduced when the slope on one side becomes smaller; the reduction on the east side is greater.

Analysis of the NRL data has established the different roles of the east ridge and the west ridge at two latitudes in the generation of internal waves at the diurnal and semidiurnal periods (See the report of the related project). The southern portion of the east ridge is the main source of the diurnal waves in the northern South China Sea. The west ridge is responsible for the weaker semidiurnal waves propagating westward from the northern section. Eastward waves are mainly at the diurnal period and are generated by the east ridge. Ms. Chen will examine these processes in greater details and further establish the phase relationship between internal waves and the barotropic tidal current quantitatively. The dependence of the strength of the internal waves on tidal currents will be investigated.

Most existing tidal simulations do not include mesoscale features such as the Kuroshio. The NRL simulation is an exception, which includes both the tidal current and the stratification variation associated with the Kuroshio. The NRL data set thus provides a unique opportunity to study dependence of the wave energy on the environmental parameters such as the position and strength of the Kuroshio.

IMPACT/APPLICATIONS

The result will be useful to predict the generation of internal solitary waves in the northern South China Sea.

RELATED PROJECTS

This project provides support for a student to work on “A Statistical Investigation of Internal Wave Propagation in The Northern South China Sea” (Award Number: N00014-10-1-0319).

REFERENCES

Qian, H., P.-T. Shaw, and D. S. Ko (2010) Generation of internal waves by barotropic tidal flow over a steep ridge, Deep-Sea Research I, 57, 1521-1531. doi:10.1016/j.dsr.2010.09.001.

Shaw, P.-T., D.-S. Ko and S.-Y. Chao (2009) Internal solitary waves induced by flow over a ridge: with applications to the northern South China Sea, Journal of Geophysical Research, 114, C02019, doi:10.1029/2008JC005007, 2009.